Benchmark Report: Performance Analysis of ProfitBricks VS. Amazon EC2 and Rackspace Cloud

A standardized, side-by-side comparison of server performance, file IO, and internal network throughput.

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CLOUD SPECTATOR

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Introduction

On 07/14/2013, ProfitBricks sponsored Cloud Spectator to run a series of benchmarks across Amazon EC2, Rackspace Cloud, and ProfitBricks US. The benchmarks were run to compare general server performance, file IO, and network. The IaaS industry has numerous individual providers offering virtualized compute power, but a lack of standardization in offerings makes it difficult for users to easily compare to find the best performance to match or exceed application requirements.

In an effort to standardize offerings, Cloud Spectator monitors the CPU, RAM, storage, and internal network performance of over 20 of the world's most well known IaaS services to understand important aspects of virtual server performance. Tests are run at least three times per day, 365 days per year to capture variability in addition to performance level. Tests are chosen based on reliability and practicality. The goal is to provide an indication of where certain providers perform well relative to others. This can give cloud buyers and cloud architects an indication of which services would be best for their application(s) by understanding the performance of provider resources most critical to that application.

Singular benchmarks alone should not be the only deciding factor in the provider selection process. Feature sets, configuration flexibility, pricing and ancillary services such as security and compliance, should always factor into any vendor selection process. However, performance is a very important piece to the puzzle.

Performance testing and benchmarking of cloud computing platforms is a complex task, compounded by the differences between providers and the use cases of cloud infrastructure users. IaaS services are utilized by a large variety of industries, and performance metrics cannot be completely understood by simply representing cloud performance with a single value. When selecting a cloud computing provider, IT professionals consider many factors: feature-sets, cost, security, location and more. However, performance is a key issue that drives many others, including cost.

Executive Summary

In general server performance, file IO, and internal network, ProfitBricks's VMs outperformed Amazon EC2 and Rackspace in all tested VMs. In a comparison with Amazon EC2, the m1.medium and m1.xlarge instances were selected for this test and the same resource configurations were matched on ProfitBricks instances. Similarly, resource capacity for Rackspace's 4GB and 15GB servers were matched on ProfitBricks instances. For more information, please see the section Server Configuration.

ProfitBricks performed at least 2x better in all tests except against Amazon EC2's m1.xlarge General Server Performance comparison, where it scored 1.8x higher. ProfitBricks's dedicated CPUs explain the increased performance against Amazon EC2 and Rackspace Cloud; while ProfitBricks users receive physical cores, Amazon and Rackspace users receive vCPU cores, which are shared physical CPUs. The network throughput results, which score as high as 20.4x than Amazon EC2 and 32x higher than Rackspace, is expected, as ProfitBricks utilizes dual InfiniBand interconnects, which deliver a bandwidth of 40Gbit/s per connection for a total of 80Gbit/s per physical server. Providers like Amazon and Rackspace achieve much lower throughput because of their inherent bandwidth limitation, which utilizes Ethernet, achieving anywhere from 1Gbit/s to 10Gbit/s bandwidth.

ProfitBricks VS. Amazon EC2 Results

General Server Performance
m1.medium: ProfitBricks scores 2.9x better
m1.xlarge: ProfitBricks scores 1.8x better

File IO Performance
m1.medium: ProfitBricks has 2.1x file throughput
m1.xlarge: ProfitBricks has 3.7x file throughput

Internal Network Throughput
m1.medium: ProfitBricks has 16.9x better internal network throughput
m1.xlarge: ProfitBricks has 20.4x better internal network throughput

ProfitBricks VS. Rackspace Cloud Results

General Server Performance
4GB Server: ProfitBricks scores 2.8x better
15GB Server: ProfitBricks scores 2x better

File IO Performance
4GB Server: ProfitBricks has 2.2x file throughput
15GB Server: ProfitBricks has 2.2x file throughput

Internal Network Throughput
4GB Server: ProfitBricks has 32x better internal network throughput
15GB Server: ProfitBricks has 15.5x better internal network throughput

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General Server Performance: UnixBench 5.1.3

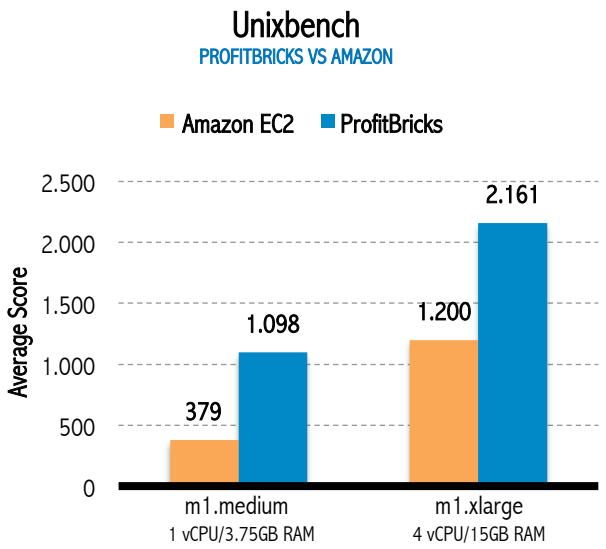
Homepage: http://code.google.com/p/byte-unixbench/
Results Used: System Benchmarks Index Score

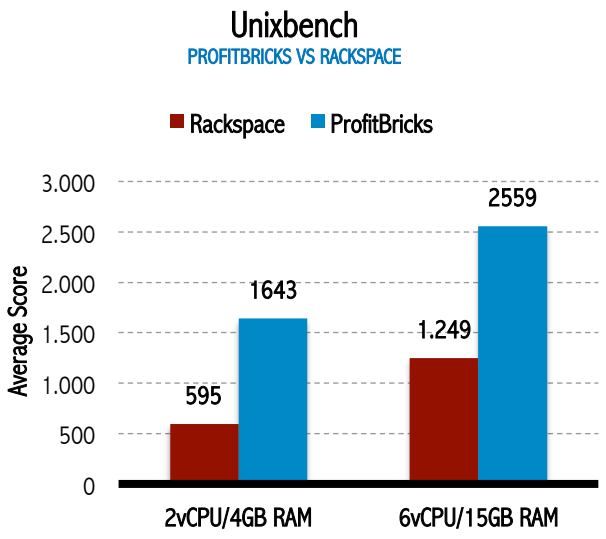
UnixBench combines a series of synthetic tests to produce a score representative of performance of a Unix-like system. Many synthetic tests are used to test various aspects of the system, such as file IO and CPU benchmarks. A single, comparable score is then given based on the results of various tests.

While Amazon EC2's score scales by 3.1x from the m1.medium to m1.xlarge, its score is still lower than ProfitBricks's comparable offerings, which score 2.9x higher on m1.medium and 1.8x on m1.xlarge. Rackspace's score scales 2.1x from its 4GB to 15GB VM, but ProfitBricks also scores higher by 2.8x and 2x on its comparable 4GB and 15GB offerings, respectively.

Test Parameters:

- get HZ environment variable to what is configured as "CONFIG_HZ_?" in the kernel configuration: "grep 'CONFIG_HZ_' /boot/config-3.2.0-49-virtual"
  - In case of Ubuntu 12.04 LTS: 250 HZ
- edit Makefile and change the following line:
  - from "OPTON = -O2 -fomit-frame-pointer -fforce-addr -ffast-math -Wall"
  - to "OPTON = -march=native -O2 -fomit-frame-pointer -fforce-addr -ffast-math -Wall"
- Compile UnixBench:
  - HZ="250" make
- Run UnixBench:
  - HZ="250" ./Run -c NR_OF_CORES
  - NR_OF_CORES equals the number of CPU cores available in each VM





Test Results

Test Iteration	Amazon 1 vCPU/3.75GB RAM	ProfitBricks 1 vCPU/3.75GB RAM	Amazon 4 vCPU/15GB RAM	ProfitBricks 4 vCPU/15GB RAM
Test 1	380	1094	1205	2172
Test 2	378	1100	1196	2167
Test 3	379	1100	1199	2145
Average Score	379	1098	1200	2161

Test Iteration	Rackspace 2 vCPU/4GB RAM	ProfitBricks 2 vCPU/4GB RAM	Rackspace 6 vCPU/15GB RAM	ProfitBricks 6 vCPU/15GB RAM
Test 1	595	1638	1250	2568
Test 2	594	1643	1246	2539
Test 3	595	1649	1250	2569
Average Score	595	1643	1249	2559

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File IO Performance: Dbench Latest Master (Jan 1 11:01:15 2013)

Repository: git clone git://git.samba.org/sahlberg/dbench.git dbench
Results Used: Throughput (as shown in the last line of the output)

Dbench generates IO workloads on a file system to stress the file system.

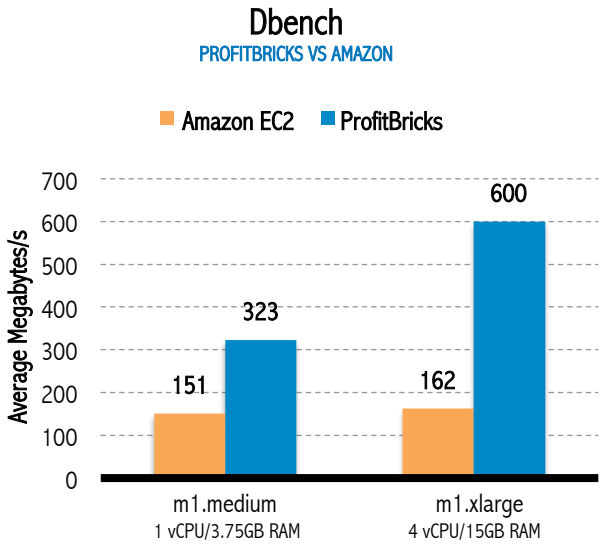
For the file IO test, ProfitBricks results increase as the server scales up, despite Dbench being a file IO test because Dbench generates pre-defined customer workloads, not randomized IO; thus, Dbench has a dependency on vCPU. Because the ProfitBricks storage backend is extremely fast, one core does not generate workload quickly enough to fully measure the disk. In short, the bottleneck in this test becomes the single-core server itself.

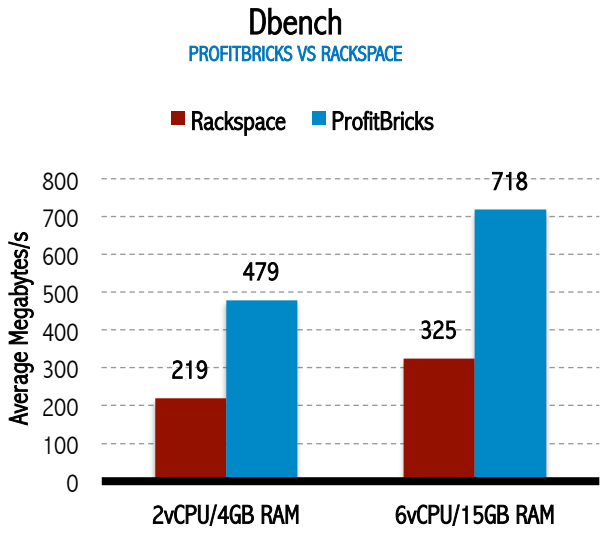
For Amazon EC2's offering, there is barely noticeable increase in disk throughput as users scale from an m1.medium instance to an m1.xlarge instance; these results are as expected (an increase of 1.1x)—Amazon's basic offering does not deliver guaranteed disk performance, and users looking for the option must purchase it with Amazon AWS Provisioned IOPS Storage; on the other hand, ProfitBricks's disk throughput increases by almost 2x as it scales from a comparable m1.medium to m1.xlarge. The discrepancy in increased throughput with scale creates a noticeable difference. On the m1.medium, ProfitBricks generates 2.1x more file throughput than Amazon EC2, but as both servers scale to m1.xlarge, ProfitBricks's file throughput increases to 3.7x that of Amazon EC2.

Rackspace disk throughput increases by 1.5x as it scales from the 4GB to 15GB VM. ProfitBricks produces a similar increase of 1.5x as it scales up with comparable offerings. With the similar increase attributed to scale, ProfitBricks continues to generate 2.2x file throughput compared to Rackspace Cloud as the VM increases from 4GB to 15GB.

Test Parameters

- Compile dbench:
  - CFLAGS="-march=native" ./autogen.sh
  - CFLAGS="-march=native" ./configure
  - make
- Run dbench:
  - ./dbench --backend=fileio -t 60 -D /benchmark/bench --loadfile=loadfiles/client.txt 48





Test Results

Test Iteration	Amazon 1 vCPU/3.75GB RAM	ProfitBricks 1 vCPU/3.75GB RAM	Amazon 4 vCPU/15GB RAM	ProfitBricks 4 vCPU/15GB RAM
Test 1	140.16	327.79	172.38	593.11
Test 2	150.96	320.75	157.13	597.88
Test 3	162.70	320.38	155.36	608.23
Average Megabytes/s	151	323	162	600

Test Iteration	Rackspace 2 vCPU/4GB RAM	ProfitBricks 2 vCPU/4GB RAM	Rackspace 6 vCPU/15GB RAM	ProfitBricks 6 vCPU/15GB RAM
Test 1	216.88	470.92	332.71	707.67
Test 2	220.35	485.83	320.45	729.75
Test 3	220.79	480.94	321.43	717.20
Average Megabytes/s	219	479	325	718

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Network Throughput Test: Iperf 2.0.5

Homepage: http://sourceforge.net/projects/iperf
Results used: Bandwidth (as shown in the last line of the output "[SUM]")

Iperf is used to test the network connection between two servers by testing the throughput. By using Iperf between server and client within the same data center, results can reveal throughput of the internal network. The difference in throughput between ProfitBricks and Amazon's servers and ProfitBricks and Rackspace's servers is sizable, with ProfitBricks achieving up to 20.4x and 32x more throughput between client and server, respectively.

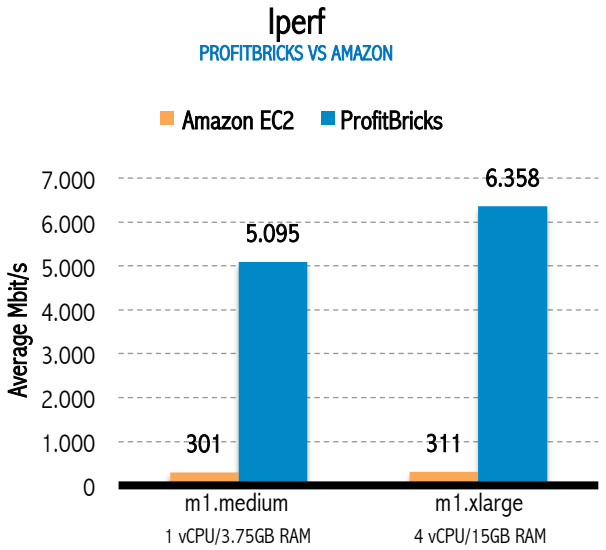
ProfitBricks's higher throughput is expected with its utilization of InfiniBand interconnects between physical servers. Each connection provides a 40Gbit/s bandwidth. With dual-interconnects, ProfitBricks achieves 80Gbit/s bandwidth between its servers. Other providers such as Amazon EC2 and Rackspace use an Ethernet connection, which can reach 1Gbit/s to 10Gbit/s bandwidth.

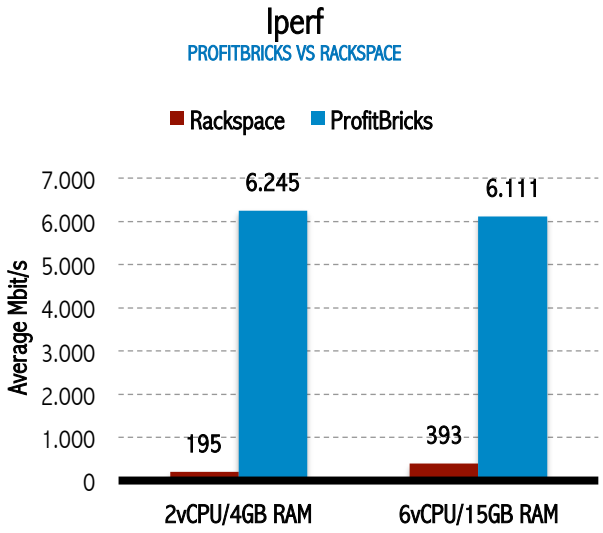
Amazon EC2's network throughput does not scale significantly as instance sizes are increased from m1.medium to m1.xlarge. ProfitBricks throughput scales slightly from 5,095 Mbit/s to 6,358 Mbit/s, a 1.2x increase.

Rackspace shows a more significant increase, from 195 Mbit/s to 393 Mbit/s, providing 2x more throughput in the 15GB RAM offering. ProfitBricks remains the largely same, with a slight decrease in throughput from 6245 Mbit/s to 6111 Mbit/s.

Test Results

- Compile iperf:
  - ./configure
  - make
- Run iperf:
  - Server: ./src/iperf -s
  - Client: ./src/iperf -c IP_OF_SERVER -f m -t 60 -P 4





Test Results

Test Iteration	Amazon 1 vCPU/3.75GB RAM	ProfitBricks 1 vCPU/3.75GB RAM	Amazon 4 vCPU/15GB RAM	ProfitBricks 4 vCPU/15GB RAM
Test 1	301	6298	316	6593
Test 2	301	4331	301	5797
Test 3	301	4655	316	6684
Average Mbit/s	301	5095	311	6358

Test Iteration	Rackspace 2 vCPU/4GB RAM	ProfitBricks 2 vCPU/4GB RAM	Rackspace 6 vCPU/15GB RAM	ProfitBricks 6 vCPU/15GB RAM
Test 1	196	6419	394	5683
Test 2	194	6500	392	5782
Test 3	194	5815	394	6869
Average Mbit/s	195	6245	393	6111

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Server Configuration and Methodology

Amazon and Rackspace offer pre-packaged VMs; a user can select a pre-set package of resources (CPU, RAM, disk) that come together in one VM. For example, on Amazon AWS, users can select an m1.medium or m1.large instance size. While this may be convenient, standardizing resources for benchmarking becomes a complicated process when the offerings between providers are not congruent.

About the Image and Test Installation

The latest Ubuntu 12.04 updates were installed during the time of testing: 07/14/2013. The Ubuntu Kernel used was 3.2.0.49.75. Each provider's standard template installation of Ubuntu 12.04 LTS was used.

The following packages were used to compile the benchmarks (In cases when the cloud provider's plain template installation did not include these packages, the packages were installed):

- make
- GCC
- automake
- libpopt-dev
- zlib1g-dev
- g++

All benchmark tools (Unixbench, Iperf, and Dbench) were downloaded from their homepages/repositories and compiled on the respective providers' VMs:

- Unixbench - http://code.google.com/p/byte-unixbench
- Dbench – git clone git://git.samba.org/sahlberg/dbench.git dbench
- http://www.sourceforge.net/projects/iperf

Each test was run 3 times and results are averaged. Specific conditions for tests:

- For Dbench and UnixBench, "-march=native" was added to the CFLAGS to optimize the code for each platform.
- For Iperf, which requires both a client and server VM, VMs were set up to run on different hardware if possible. That ensures that the physical network is tested, not just a local bridge.
- On UnixBench, 13 total tests within the suite were run, not including the 2D and 3D tests, which do not contribute to the final score. The 13 tests are:
  - Dhrystone 2
  - Double-precision Whetstone
  - Execl Throughput
  - File copy (1024 bufsize 2000 maxblocks)
  - File copy (256 bufsize 500 maxblocks)
  - File copy (4096 bufsize 8000maxblocks)
  - Pipe Throughput
  - Pipe-based Context Switching
  - Process Creation
  - Shell Scripts (1 concurrent)
  - Shell Scripts (8 concurrent)
  - System Call Overhead
- For Dbench and UnixBench, both of which test file IO, a separate block device was set up without partitioning, which was formatted with ext4 and mounted to /benchmark. The Ubuntu 12.04 defaults were used for the mkfs and the mount:
  - Mkfs.ext4 /dev/second_device
  - Mount /dev/second_device /benchmark

Amazon EC2 VS. ProfitBricks

Provider	vCPU	RAM	DISK
Amazon EC2	1	3.75 GB	Ext4
ProfitBricks	1	3.75 GB	Ext4

Provider	vCPU	RAM	DISK
Amazon EC2	4	15 GB	Ext4
ProfitBricks	4	15 GB	Ext4

*For Amazon AWS, an Elastic Block Storage (EBS) instance of 50 GB was used to install the image and run the tests.

Rackspace Cloud VS. ProfitBricks

Provider	vCPU	RAM	DISK
Rackspace Cloud	2	4GB	Ext4
ProfitBricks	2	4GB	Ext4

Provider	vCPU	RAM	DISK
Rackspace Cloud	6	15GB	Ext4
ProfitBricks	6	15GB	Ext4

ProfitBricks offers fully configurable VMs. Users of ProfitBricks can create their own instance with independently scalable resources of CPU, RAM, and disk. Its unique RAM offering can be configured to scale by 256MB, rather than 1GB. Because Amazon's m1.medium and m1.xlarge instances have 3.75GB and 15GB RAM, respectively, ProfitBricks's granular scaling options allow for fine-tuning in a standardized performance comparison. Similarly, with Rackspace Cloud, ProfitBricks servers can be adjusted to match in resources. By separating and comparing ProfitBricks VS. Amazon AWS and ProfitBricks VS. Rackspace Cloud separately and standardizing VMs with each test, we achieve an accurate comparison.

Time Frame

All three tests were run on 7/14/13.

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About Cloud Spectator

Cloud Spectator is the premier international cloud analyst group focused on infrastructure pricing and server performance. Since 2011, Cloud Spectator has monitored the cloud infrastructure (IaaS) industry on a global scale and continues to produce research reports for businesses to make informed purchase decisions by leveraging its CloudSpecs utility, an application that automates live server performance tests 3 times a day, 365 days a year with use of open source benchmark tests. Currently, the CloudSpecs system actively tracks 20 of the top IaaS providers around the world.

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About ProfitBricks

ProfitBricks - Cloud Computing 2.0 - is the cloud infrastructure-as-a-service (IaaS) company offering more speed and flexibility than any other cloud provider. Founded in 2010 by the previous co-founders of 1&1 Internet, ProfitBricks has built the world's first, true virtual datacenter, enabling users custom defined instances with live vertical scaling and class-leading double redundant cloud storage – all with simple and transparent minute-based billing. It also developed the first graphical Data Center Designer that makes the ProfitBricks Cloud Computing service the easiest to setup and maintain. CRN Magazine recently picked ProfitBricks as the "Coolest Startup" of 2012. Headquartered in Berlin, Germany and Boston, Mass., ProfitBricks can be found online at www.profitbricks.com.

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